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Correlation between Hearing Threshold, Tinnitus Pitch and Loudness with Quality Of Life of Tinnitus Patients in Makassar

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ABSTRACT

Introduction: Tinnitus is an unwanted auditory perception, with many causes, subjectively and affects the quality of life. It is important to evaluating the quality of life of tinnitus patients and related factors in treatment of tinnitus. The measurements of tinnitus psychoacoustic include pitch, loudness, minimum masking levels and residual inhibition.

Aim: To analyze the correlation between hearing threshold, tinnitus pitch and loudness with quality of life of tinnitus patients in Makassar.

Methods: This was an analytic observational study with cross sectional design that has been approved by the Ethical Review Health Committee, Faculty of Medicine of Hasanuddin University number UH13070267. One hundred tinnitus patients were measured hearing threshold, tinnitus pitch and loudness by matching test method. The quality of life was assessed by Tinnitus Handicap Inventory (THI) questionnaires. Data was analysed using chi-square test, Kruskal-Wallis and Rank Spearman correlation test. Results: There was a statistically significant correlation ($p < 0,05$) between hearing threshold, tinnitus pitch and loudness with quality of life of tinnitus patients. Tinnitus patient with hearing loss have a poorer quality of life than individuals without hearing loss. High pitch and loudness are more disturb quality of life of tinnitus patients.

Conclusion: The results of our study highlight the importance of hearing threshold, tinnitus pitch and loudness as major components effect quality of life of tinnitus patients. The tinnitus psychoacoustic measurement should be a routine examination for tinnitus patients.

Keywords: tinnitus, hearing threshold, pitch, loudness, quality of life

INTRODUCTION

Tinnitus is the conscious expression of a sound that originates in an involuntary manner in the head of its owner, or may appear to him to do so. ^[1] It is a common experience in adults and children. Adult data from the MRC Institute of Hearing Research indicate that, in the UK, 10% of adults have

experienced prolonged spontaneous tinnitus, and that in 5% of adult tinnitus is reported to be moderately or severely annoying. In 1% of the adult population, tinnitus has a severe effect on quality of life. ^[2]

Tinnitus can occur in a variety of intensities. In some people, tinnitus can be a problem effect quality of life such as

distraction, sleep and work disturbance, anxiety, and depression. [3] Sissons reported five main categories of complaint contributing to tinnitus distress. These were emotional distress and patient's view of tinnitus, sleep disturbance, auditory perceptual difficulties, interference with work and leisure, as effect on general health. [4]

Many theories and models have been proposed to explain the pathophysiological basis of tinnitus. The most prevalent theories involve hair cells, the auditory nerve, and the central auditory nervous system. Theories involving hair cells include discordant hair cell function. [5] The main problem with tinnitus is that it is a subjective symptom so there is no measurement of tinnitus that really objective. Attempts have been made previously to match tinnitus pitch, timbre and intensity, and make the assumption that the characteristics of an external sound can be meaningfully related to those of an internally generated sound. [4]

A tinnitus psychoacoustic assessment should also be part of the intake evaluation. With masking treatment, it is always crucial to measure or document the effects of masking stimuli on the perception of tinnitus. Tinnitus measures also generally are important for individualized counseling purposes, especially in treatments such as Tinnitus Retraining Therapy. Psychoacoustic measures also are valuable in evaluating and verifying the patient's subjective reports of his/her tinnitus condition when the patient is involved in legal action related to the tinnitus. [5] But there is a consensus that psychoacoustic test of this kind give little or no useful information regarding tinnitus severity. [4] Because most tinnitus patients also have some hearing impairment, routine audiological testing is recommended for all patients who seek treatment for their tinnitus. Audiometric evaluation should

include pure-tone thresholds, speech-recognition thresholds, word-recognition scores, and immittance measures. [5]

The psychoacoustic of tinnitus can be assessed by matching test. A protocol for loudness and pitch matching was described in detail by Vernon and Meikle (1981). Their protocol involves three separate procedures that are alternated systematically among threshold testing, loudness matching, and pitch matching. The objectives are to achieve a pitch match and a loudness match at the pitch-match frequency. In general, the tinnitus frequency is approached gradually by presenting successive pairs of tones from which the patient selects the tone that is "closest in pitch and loudness" to the tinnitus. [5] Some researchers showed that generally tinnitus frequencies above 3000 Hz, [6,7] with over 10 dBSL intensity. [8,9]

The effects of tinnitus on quality of life are highly individualized, and personality characteristics may predispose a person to experience tinnitus as a "distressing" symptom. There are at least a dozen published outcome instruments that are used to obtain tinnitus severity ratings. Most tinnitus questionnaires provide an index score to quantify the impact of tinnitus on the patient's activities. [5] Tinnitus Handicap Inventory is a group questionnaire developed by Newman, Sandridge and Jacobson (1998). It has been validated with good level of validity and reliability in measuring the variables that affect quality of life of tinnitus patients. [10] THI places the patient into one of four "handicap severity" categories (none, mild, moderate, and severe). [11]

Assessing quality of life of tinnitus patients is very important in planning and monitoring the effectiveness of therapy. On an epidemiological study of adult tinnitus patients who were observed for 5 years in the United States in 1998 showed that patients with hearing loss have a greater risk

of suffering from tinnitus than in normal hearing.^[12] Patient's quality of life should be an important concern because it can be a reference for evaluating the treatment. In addition, data on quality of life can also be the initial data for consideration formulate appropriate interventions for patient. The relation between psychoacoustic tinnitus measurement and quality of life of tinnitus patients have never been obtained in Makassar. This study aimed to assess the correlation between hearing threshold, tinnitus pitch and loudness with quality of life of tinnitus patients.

MATERIALS AND METHODS

This study was analytic observational study with cross sectional design. This study received approval from The Ethical Review Health Committee, Faculty of Medicine, University of Hasanuddin Makassar number UH13070267. One hundred subjective tinnitus patients were included in this study. The study was carried out for 5 months, from May to October 2013, in ENT clinic of Wahidin Sudirohusodo Hospital, Makassar, South Sulawesi.

As for the analysis of data collected, the following parameters were considered: age, sex, tinnitus laterality (unilateral or bilateral), hearing threshold, tinnitus measurements (pitch and loudness) and subjective disturbance caused by tinnitus.

All the subjects were submitted to anamnesis, ENT physical examination, and pure tone audiometry for 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, 8000 Hz (air and bone conduction) using a clinical audiometer. The hearing threshold was considered as the pure tone average for the frequencies 500-1000-2000-4000 Hz and divided in: normal hearing (<25dB) and hearing loss (>25dB).

Tinnitus pitch and loudness are determined by matching test.^[5] Loudness

and pitch matching are performed using a clinical audiometer as follows. After a pure-tone audiogram had been obtained, we focused on obtaining a pitch match and a loudness match at the pitch-match frequency. Initial loudness-matching tones should be presented at 10–20 dB SL at frequencies where hearing sensitivity is essentially normal and at 5–10 dB SL at frequencies where there is hearing loss. The testing was started at 1000 Hz. The patient is asked, “Is the pitch of your tinnitus higher or lower than the pitch of the tone?” If the patient indicates “higher”, the next tone is presented at 2000 Hz. The testing progresses in this manner to bracket the tinnitus pitch to within an octave. Inter-octave frequencies are then tested the same way to determine a pitch match to the closest half octave. Patients often confuse octaves when pitch matching, so we should alternate presentation of the pitch-matched tone with tones an octave higher and an octave lower to identify the final pitch match. At the pitch-matched frequency, a hearing threshold and tinnitus loudness match are then obtained in 1-dB steps.

To evaluating the quality of life of tinnitus patients, Tinnitus Handicap Inventory (THI) was administered. This tool is a 25 item survey that is composed of three subscales: a functional subscale (12 items), an emotional subscale (8 items) and a catastrophic response subscale (5 items) which address role and physical functioning, psychological distress, desperation and loss of control, respectively. Each item has 3 potential answers with “yes” assigned 4 points, “sometimes” 2 points, and “no” 0 points. Subjects were classified into four categories: group I: no distress (scores 0-16); group II: mild distress (scores 18-36); group III: moderate distress (scores 38-56); group IV: severe distress (scores 58-100).

For the statistical analysis the chi-square, Kruskal-Wallis and Rank Spearman

correlation test was calculated using computerized statistical analyzing programme. The level of significance was set at 0.05%, with 95% confidence intervals.

RESULTS

Table 1. Distribution of sample characteristics based of sex and age

Variable	n	%
Sex		
Male	42	42.0
Female	58	58.0
Age :		
a. 15-20 y.o.	3	3.0
b. 20-30 y.o.	8	8.0
c. 31-40 y.o.	6	6.0
d. 41-50 y.o.	21	21.0
e. 51-60 y.o.	26	26.0
f. 61-70 y.o.	36	36.0

One hundred patients with tinnitus (42 males, 58 females) were included in this study, age between 15 and 70 years. The distribution of sample characteristics is indicated in table 1.

Tinnitus was referred as unilateral in 74 patients (74%), 30 cases in the right ear and 40 cases in the left ear; bilateral in 26 patients (26%). As for audiometric threshold in tinnitus ear, it was revealed normal hearing in 12% of cases and 88% of cases with hearing loss, from mild to severe. On the contralateral side of tinnitus ear, it was normal hearing in 36% of cases and 64% of cases had hearing loss, from mild to very severe (table 2).

Table 2. Sample distribution based on hearing threshold in tinnitus ear and contralateral side

Tinnitus Ear	Count	%	Contralateral side	Count	%
Normal hearing	12	12.0	Normal hearing	36	36.0
Hearing loss			Hearing loss		
Mild	24	24.0	Mild	22	22.0
Moderate	29	29.0	Moderate	22	22.0
Moderate-severe	17	17.0	Moderate-severe	13	13.0
Severe	17	17.0	Severe	6	6.0
Profound	1	1.0	Profound	1	1.0

The tinnitus frequency, measured by the pitch-matching test, was matched to high frequencies (≥ 2000 Hz) in 72 patients (72%), to low frequencies (< 2000 Hz) in 28 patients (28%). The loudness matches for tinnitus, as estimated by audiometry, was 53.62 dBHL in mean value (15-97 dBHL) or 11.01 dBSL (0-30 dBSL).

Table 3. Sample distribution based on quality of life (THI score)

Quality of life	n	%
No distress	19	19.0
Mild distress	30	30.0
Moderate distress	27	27.0
Severe distress	24	24.0
Total	100	100.0

Regarding tinnitus annoyance and its impact on the quality of life, the THI four categories of tinnitus severity: no distress grade was found in 19 patients (19%); mild grade in 30 patients (30%); moderate grade in 27 patients (27%) and severe grade in 24 patients (24%) (Table 3).

Relationship between threshold hearing and quality of life of tinnitus patients are showed in table 4. Spearman rank correlations statistics indicate a positive correlation between hearing threshold with quality of life of tinnitus patients ($r = 0.334$; $p = 0.001$), which means the more disturbed of hearing threshold, the more impaired the quality of life of tinnitus patients.

Spearman correlation test also showed a correlation between pitch of tinnitus with quality of life of tinnitus patients ($r = 0.335$; $p = 0.001$). It was means high-pitched tinnitus more affects quality of life of tinnitus patients.

Kruskal-Wallis test was used to analyze relationship between tinnitus loudness with quality of life of people with tinnitus. There were differences in loudness of tinnitus in the groups of quality of life ($p < 0.05$). Spearman correlation test show a

moderate relationship, statistically significant, between tinnitus loudness and

quality of life of tinnitus patients ($r = 0.442$; $p = 0.000$).

Table 4. Relationship between threshold hearing and quality of life of tinnitus patients.

Hearing threshold on tinnitus ear	Quality of life								P
	No distress		Mild distress		Moderate distress		Severe distress		
	n	%	n	%	n	%	n	%	
Normal hearing	6	50,00	2	16,67	1	8,33	3	25,00	0,024
Hearing loss	13	14,77	28	31,82	26	29,55	21	23,86	
Total	19	19,00	30	30,00	27	27,00	24	24,00	

Chi-square test

Table 5. Relationship between tinnitus loudness and quality of life

Quality of life	n	Tinnitus loudness				p
		Median (min-max)	Mean	SD		
No distress	19	35.0 (20.0 – 68.0)	39.37	3.07		0,00
Mild distress	30	40.0 (15.0 – 75.0)	44.10	2.48		
Moderate distress	27	60.0 (20.0 – 90.0)	62.63	3.57		
Severe distress	24	70.0 (25.0 – 97.0)	66.67	4.63		

Kruskal-Wallis test. Post-hoc Mann-Whitney test of groups: No distress vs Mild distress $p = 0.101$; No distress vs Moderate distress $p = 0.000$; No distress vs Severe distress $p = 0.000$; Mild distress vs Moderate distress $p = 0.000$; Mild distress vs Severe distress $p = 0.000$; Moderate distress vs Severe distress $p = 0.461$

DISCUSSION

This study shows a higher incidence of tinnitus complaint in female subjects (58%). This is in agreement with literature, although this study did not show statistical significance. [13] Johansson et al. [14] and Palmer et al. [15] reported a minimally higher, but not statistically significant, prevalence overall for male than female. Women are more likely to report emotional reactions to their tinnitus than men. [5] We observed that tinnitus was more frequent among individuals whose age ranged from 61 and 70 years old. Researches also reported a higher occurrence of tinnitus complaint in senior citizens. [13]

The increase in tinnitus prevalence in older patients does not necessarily mean that tinnitus as a separate and distinct symptom will increase with age. The International Work Group on Hearing Problems and the Elderly [16] concluded that the incidence of tinnitus was not greater than that expected for older patients with hearing loss and other age-related diseases; in addition, the pathophysiology of tinnitus in older patients

was the same as that in younger patients. Others have argued that age-related tinnitus exists as a distinct pathology and is related to degeneration at all levels of the auditory system. For the aged population, tinnitus may go unreported or may be given less importance in the context of other significant medical problems. [5]

The results show a statistically significant association between hearing threshold and quality of life of people with tinnitus. Spearman correlation rank 0.334 indicates a positive correlation between them. Davis [17] argued that tinnitus which frequently accompanied by hearing loss showed damage in the cochlea is the cause of the onset of the tinnitus complaint.

There is a clear relation between hearing loss and tinnitus, and the majority of tinnitus patients have some degree of hearing loss. [5] Vernon and Meikle [18] (2000) reported that 70% to 80% of tinnitus patients have “significant hearing difficulties”. Because hearing loss and tinnitus are so closely related, populations with more prevalent hearing loss have a

correspondingly greater prevalence of tinnitus. The prevalence of hearing loss increases with age, especially after age 65. Thirty percent of all individuals between the ages of 65 and 74 years and 50% of those persons 75 years and older have hearing loss. [19]

A national study of hearing conducted by Coles et al. showed that the severity of tinnitus correlate with the degree of hearing difficulty. Slight hearing difficulty most commonly goes with slight tinnitus annoyance, and no hearing at all with severe tinnitus annoyance. [17] Tinnitus pitch measurement results conducted several studies have varying results. Safitri [20] reported similar results with our study, i.e. 60.7% of tinnitus patients had tinnitus frequency between 2000 and 8000 Hz. Available data from several large patient samples have confirmed that the majority of tinnitus pitch matches are above 3000 Hz.

The pitch of tinnitus usually corresponds to a frequency region in which the individual's hearing is abnormal. In view of the tendency for adventitious hearing loss to affect the high frequencies first, it is perhaps not surprising that tinnitus is often perceived as a relatively high-frequency sound. Henry et al. [6] found a low-frequency tinnitus in patients with low-frequency hearing loss. Pan Tao [21] also reported that a low-frequency tinnitus (<2000 Hz) tend to be obtained on individual with reduced hearing threshold on low-frequency.

In this study, there was a significant correlation between tinnitus pitch with quality of life of tinnitus patients. Tinnitus high-frequency more effect on quality of life than low frequencies. Delbet al. [22] reported a tendency, but not statistically significance, the patients with high tinnitus impact to have a higher tinnitus pitch. High-pitched tinnitus is not easily masked by environmental sounds and this affects the communication ability. Mitchell et al. [23]

found a significant correlation between the measurements of tinnitus frequency with the measurements of minimum masking levels (MMLs). The higher the tinnitus tone is obtained, the greater the masking tone needed to mask the tinnitus sound.

Tinnitus loudness measurement conducted several studies have varying results. Safitri [20] reported the tinnitus mean loudness was 35.5 dBHL or 9.5 dBSL. Anderson [8] reported the results of tinnitus loudness measurements was 44, 1 dBHL with standard deviations 23,7 dBHL. In this study, the Kruskal-Wallis test to assess relationship between the tinnitus loudness with quality of life distress obtained significant relationship. Post-hoc Mann-Whitney test showed that the groups which have significant correlation: No distress vs. moderate distress ($p=0.000$); No distress vs. Severe distress ($p = 0.000$); Mild distress vs. Moderate distress ($p = 0.000$); and Mild distress vs. Severe distress ($p = 0.000$). Spearman correlation test obtained $r = 0.442$ show a positive correlation.

Tinnitus loudness is one important variable to explain tinnitus individual differences. The louder the perceived tinnitus sound will be more difficult to accept and resolve complaints than the tinnitus slowly. Some patients describe their tinnitus as very noisy or louder than most or even all environmental sounds. A high degree of signal intensity could explain why a group expresses strong complaints or develops psychosocial disability. Many patients are convinced that the loudness of their tinnitus is a crucial factor in their quality of life. They argue that loud noises hinder habituation and acceptance, whereas they consider a relatively soft signal as easier to tolerate and integrate into normal life. Whether this perspective is supported by empirical evidence is debatable. Some authors have reported only small or moderate correlations between tinnitus

loudness on one side and the severity of associated distress and handicap on the other side, whereas others have found tinnitus loudness to be significantly predictive of perceived severity. [24]

CONCLUSION

As conclusion, the results of our study highlight the importance of hearing threshold, tinnitus pitch and loudness as major components effect quality of life of tinnitus patients. Tinnitus patient with hearing loss have a poorer quality of life than individuals without hearing loss. High pitch and loudness are more disturb quality of life of tinnitus patients. The tinnitus psychoacoustic measurement should be a routine examination for tinnitus patients.

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